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United States Department of Agriculture,

DIVISION OF BOTANY.

HORSE-RADISH.

By M. G. KAINS.

The well-known condiment horse-radish¹ is prepared from the root of a plant that belongs to the same natural family as the cabbage, turnip, wallflower, stock and many other vegetables and flowers, and to which also belong charlock, mustard, shepherd's purse, and several other noxious weeds.

The plant, which is a hardy perennial, is thought to have been naturalized in Great Britain from some more eastern European country. It is found growing wild in moist locations along the margins of streams, in cool, open woods, wet meadows, and other situations. From England it has been carried to many countries in the temperate zones to be used for culinary purposes. It has, however, often made its escape from cultivation, and has sometimes, as in parts of the State of New York, become troublesome as a weed.

The roots are fleshy, whitish externally, and very white within; conical at the top, then cylindrical for several inches, not forming a taproot like a carrot or parsnip, but abruptly branched at the lower end, the more or less widely spreading branches slowly tapering below. The rootlets have been known to clog tile drains at a depth of 7 feet. When bruised or scraped the root emits a strong, pungent odor; when eaten it is hot and biting. These peculiarities are imparted to water and to alcohol and are due to an essential oil, which is dissipated by drying, the root becoming at first sweetish and ultimately insipid and inert. The oil, obtained by distillation with water, is colorless or pale yellow, heavier than water, very volatile, excessively pungent, acrid, and corrosive, exciting inflammation and even vesication when applied to the skin. According to Gutret only six parts of this oil, which Hubatka considers as identical with the essential oil of mustard, are obtained from 10,000 parts of the root.

"Horse-radish," says the United States Dispensatory,² "is highly stimulant, exciting the stomach when swallowed, and promoting the secretions, especially that of urine. Externally it is rubefacient. Its chief use is as a condiment and to promote appetite and invigorate digestion; but it is also occasionally employed in medicine, particularly in dropsy attended with enfeebled digestion and general debility. It has, moreover, been recommended in palsy and chronic

¹ *Roripa armoracia* (L.) A. S. Hitchcock; *Nasturtium armoracia* (L.) Fries.

² U. S. Dispensatory, 17th edition, p. 228. (1896.)

planted flat, this cutting is not necessary, since the root will in any case be in a normal position. The crown of the roots with a small piece of the root adhering is sometimes used in planting, but this practice is not usually satisfactory, since the crowns do not produce single well-formed roots, but develop a number of small roots that are generally not of sufficient size for grating.

PLANTING.

After the ground has been prepared, shallow furrows are made $2\frac{1}{2}$ feet apart and from 2 to 5 inches deep, according to the method of planting. In these furrows the sets are dropped. Some growers place them flat, some perpendicular, and others at intermediate angles, but always when set otherwise than horizontal, with the large, or upper, end nearer the surface of the ground than the small end. It is also usual, except in perpendicular planting, to point the upper ends in one direction, so that the row may be kept straight all the season through and the digging may be facilitated. Just which of these methods of planting is the best can not at present be stated. It is probable that they are all good, as each grower finds his particular plan successful.

Where the ground is shallow a favorite plan of growing the root is in ridges, which are made from a foot to eighteen inches high and three feet wide. The sets are then dibbled in obliquely at intervals of about 10 or 12 inches along the sides of the ridge. When growth has begun, a shallow drill is made along the top of the ridge for liquid manure or sewage. In the preparation of the sets for this method of planting the roots are slightly scraped to remove incipient buds, since fewer lateral roots are believed to be formed from sets treated in this way. The application of the manure at the base of the ridge seems, in view of what has been said above, to be better than its application at the summit.

A simple method of setting the roots, when planting on a small scale, is to thrust a spade full depth into the bed, work it forward and back to make the hole wider, and after placing a set at each side of the hole to drive the spade down beside the first hole and press the earth close against the roots already set.

Some growers practice the removal of the side roots. This is done by carefully lifting the set after it has started to grow, stripping off the rootlets with the exception of the terminal one, and cutting away all but one crown. The roots are then replaced and are said to produce finer specimens than are usually obtained in the ordinary way.

CULTIVATION.

If the soil has been prepared and the weeder has been used as already described, the further cultivation of horse-radish is usually easy. The cultivator may be run between the rows once a week and after each rain until the leaves of the plant pretty well cover the ground. This will generally be done before the hot weather arrives. When once the leaves shade the ground the weeds will cease to be troublesome and the shade will take the place of the soil mulch in checking evaporation.

DUAL CROPPING.

It is a common practice among market gardeners to plant horse-radish with early cabbage, turnip beets, or other quick-maturing crop. In this way the land is made to do double duty, until the first crop is removed, with practically the same preparation, cultivation, and manure. Soon after the removal of the first crop the horse-radish leaves should cover the ground and cultivation cease.

It is usual, where this practice is followed, either to plant the cabbage two to four weeks before the horse-radish sets, which are always in this case dibbled in in a vertical position, or to bury the sets somewhat deeply just before the cabbage plants are transplanted to the field. The object in each case is to retard the appearance of the second crop until the first is approaching maturity and its cultivation is virtually at an end. When planted between the rows the sets should be placed about 18 inches apart and the rows should be 2 to 3 feet apart. Should the horse-radish commence to appear before the cabbage is harvested little or no injury will be done if its leaves are cut off by the cultivator. After the cabbage has been harvested one cultivation will generally be found sufficient for the horse-radish crop before laying it by.

HARVESTING AND STORING.

Since horse-radish makes its best growth during the cool autumn months, since it steadily improves in quality after September, and, since the roots, if still in the ground, are not injured by frost, the digging is usually deferred until late fall or at least until the more tender crops are all attended to. For home use it is often left in the ground all winter and pried up with a pickax when needed. The digging may be done with a spade, or upon a larger scale with a plow.

It is important that the roots be removed entire, since even small pieces left behind will grow. Careful lifting and thorough cultivation should, however, prevent any serious trouble from bits accidentally left behind.

* The storing of the roots may be either in root cellars or in pits. As a general thing the pits are to be preferred, since the roots so stored retain their good appearance, their crispness, and their pungent flavor better than when stored in cellars. When the roots are trimmed for storage the lateral branches are saved, trimmed, and buried or stored in sand in root cellars, to be used the following season for the production of a new crop. At no time should the roots be left exposed to the sun and air, since they lose more or less of their good qualities by such treatment.

HOME-GROWN HORSE-RADISH.

In growing horse-radish for home use a plot of ground 3 by 5 feet in any convenient place that is not too dry should be selected and should be well manured and deeply dug before setting the roots in it. These may be set at intervals of 18 inches and about 2 inches below the surface, which should be kept free from weeds until the leaves fully shade the ground.

The roots may be dug at any time after September, the later the better. They need not be stored during the winter; in fact, they will usually be better if left in the ground and removed only as needed. They are not injured by frost and may be taken up with a pickax if the soil is frozen hard. They will generally be found to deteriorate as the growing season advances, but may be used up to and even after the appearance of the leaves. A dozen roots should be plenty to start with. After they are once established the only attention they will need will be an occasional dressing of fertilizer and the prevention of their spreading to contiguous parts of the garden. This may be easily accomplished by digging a trench about the width of the spade around the patch and removing all horse-radish roots in it before returning the earth to the trench.

ENEMIES.

The horse-radish is seldom troubled to any great extent by plant diseases. The fungous parasites *Albugo candidus* and *Phytophthora parasitica* occasionally attack it severely enough to destroy the leaves and to prevent the perfect formation of the root, but these visits are of comparatively rare occurrence and are probably dependent, principally, upon the season. No remedy can be recommended, since the diseases have not become important enough to demand experiment in their control.

Only one insect¹ has been reported in America as a specific foe to the plant. This is a flea-beetle imported from Europe. It has as yet not been markedly troublesome, but since its introduction has been of comparatively recent date, as far as known, it may be suspected of being a dangerous enemy.

Many of the insects that attack cauliflower, radish, and other cruciferous plants may often be found upon the horse-radish. Of these no other is of so great importance as the harlequin cabbage bug, an insect which has been figured and described by the Division of Entomology of this Department.² This insect has been exceedingly troublesome around Washington, and unless some effective remedy can be found it seems to be only a question of time when the raising of horse-radish, and indeed other cruciferous plants, must in the vicinity of the Capital be abandoned. The only remedy that has given any degree of satisfaction is the trap crop. Common radish or mustard seed is planted as early in the spring as possible. In the absence of other food the bugs collect upon the young plants and then may be killed by a spray of pure kerosene or kerosene emulsion diluted with only one part of water. Of course this remedy destroys the plants along with the bugs. The trap may prove useful through the season if the radishes are planted between the rows of horse-radish and the kerosene applied as mentioned. This method has been found effective in the raising of cabbage and may be equally successful in the growing of horse-radish.

¹ Insect Life, vol. 7, p. 404. (1895.)

² U. S. Department of Agriculture, Division of Entomology, Circular No. 10, second series. (1895.)

YIELD AND PROFITS.

Horse-radish at present prices is a profitable crop in the vicinity of cities, and is especially so near the seaboard, where oysters are cheap. The usual price for the freshly shredded root in these markets is 10 cents a pint without vinegar. A pint will not weigh more than about half a pound.

The following figures, which represent the cost of raising an acre of horse-radish, have been furnished by Mr. B. D. Shedaker, of Edgewater Park, N. J., who grows this crop extensively:

Cost of raising an acre of horse radish.

10,000 cuttings at \$2 per 1,000.....	\$20.00
1,000 pounds fertilizer	17.50
Cultivation (6 times)	6.00
Setting roots, at 30 cents per 1,000.....	3.00
Rent of land	5.00
Total	51.50

To these figures must be added the cost of plowing, wear of tools, etc., which should make the total cost not far from \$55 an acre.

From 3,000 to 6,000 pounds of marketable roots may be easily grown per acre and these may be readily sold in bulk to bottlers at 3 to 4, sometimes as high as 5 cents per pound for number one root, and from 1 to 2½ cents for number two. Under good cultivation the quantity of number one root should be at least as great as of number two. When sold in small quantities to horse-radish graters in the city markets even higher prices may often be obtained. It is possible that in certain localities where the raising of horse-radish has been carried to extremes, lower prices rule, and that in sections where it is little grown higher prices may be obtained; but it seems that if the raising of this root be not carried to excess the returns should be satisfactory, barring the accidents of season and enemies.

PREPARATION AND USES.

Horse-radish is a familiar condiment when grated and mixed with vinegar, for which use the fresher it is the better. If exposed to heat and air it will lose its peculiar pungency within an hour and will soon become insipid and inert. When grated for mixing with vinegar the combination should be made at once and the mixture hermetically sealed in pickle bottles or fruit jars. When used without vinegar it should be grated immediately before being served, or should, if prepared earlier, be closely covered and set in a cool place. The grater usually seen in the markets is a wooden cylinder studded with steel pegs half an inch long. This forms a drum which is driven by a treadle.

Besides this common method of preparing the root, horse-radish is prepared in several other ways, two of the best of which are here given.

Horse-radish sauce.—Cover one pound of sliced root with spirits of wine, 95 per cent alcohol, and keep tightly corked. This is added, drop by drop, to any of the white sauces used for meats or fish, until the desired flavor is obtained. When mixed with a little fresh

mustard and a little red pepper this tincture makes an excellent sauce for broiled beef or deviled chicken. On account of its volatile nature it should never be left uncorked, and should be added to the final sauce just before being served.

Horse-radish vinegar.—Soak a cupful of freshly grated root, together with an ounce of minced shallots or onions, one clove of garlic, and a pinch of red pepper in a quart of cider vinegar. After being kept tightly corked for a week, strain the liquid through a cloth and bottle it for use. It makes a pleasant addition to many salads.

HORSE-RADISH AS A SALAD AND A POT HERB.

It is not generally known that a fine salad may be grown from horse-radish in almost the same manner as *barbe de capucin* is grown from chicory roots. The horse-radish roots are dug in late autumn and the crowns left intact. They are then buried standing upright in moist (not wet) earth, in a dark, warm cellar or underneath a greenhouse bench and the leaves forced as rapidly as possible. When these are about 3 or 4 inches long they may be cut and used either singly or mixed with other plant salads. If darkness prevails during their growth the leaves will be white and tender and will have a sweetish pungency, but if allowed to have light they will be green and tough and too strong for use as a salad.

The leaves of the plant when grown in the garden are sometimes used as a pot herb, but they are not specially adapted for this purpose, since they are likely to be stringy and coarse unless very young. They have, moreover, a bitter taste, which is difficult to remove unless the water in which they are boiled is changed several times.

Publication recommended.

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WASHINGTON, D. C., May 20, 1898.



